In the Specification

[0017] A first inventive etch embodiment comprises the combination of a halogen-containing gas, for example Br, HBr, CF_4, NF_3, Cl_2, or HCl, and an oxygen-containing gas, for example O_2 or ~~HeO_2~~ $He\text{-}O_2$ in an etcher which is top and bottom powered or modified to be top and bottom powered. Various other similar gasses may function sufficiently, and suitable high-density etchers include an Applied Materials DPS or HDP, a LAM model 9400 or TCP, or other such etchers.

[0020] The flow rate of the halogen-containing gas is preferably in the range of about 35 standard cubic centimeters (sccm) to about 65 sccm, more preferably in the range of about 45 sccm to about 55 sccm, and most preferably about 50 sccm. The oxygen flow rate of the oxygen-containing gas is preferably in the range of about 1.9 sccm to about 4.7 sccm, more preferably between about 2.4 sccm and about 4.0 sccm, and most preferably between about 2.7 sccm and about 3.6 sccm. The total flow rate of the oxygen-containing gas can easily be determined by one of ordinary skill in the art. As an example, using ~~HeO_2~~ $He\text{-}O_2$ as the oxygen-containing gas, the total flow rate of the ~~HeO_2~~ $He\text{-}O_2$ (helium and oxygen components) is preferably in the range of about 6.3 sccm to about 15.6 sccm, more preferably between about 8.1 sccm and about 13.2 sccm, and most preferably between about 9 sccm and about 12 sccm, as the ~~HeO_2~~ $He\text{-}O_2$ gas mixture comprises 30% oxygen and 70% helium. Using the preferred settings described above, the polysilicon will be etched at a rate of between about 1,000Å/min and about 2,000Å/min.

[0025] FIGS. 5-7 depict etch results on test wafers which can be expected with increasing flow rates of ~~HeO_2~~ $He\text{-}O_2$. Similar results can be obtained with other oxygen-containing gasses. Each of FIGS. 5-7 comprise the use of a silicon wafer having blanket layers of polysilicon about 900Å thick, a silicide layer about 1,000Å thick overlying the polysilicon, a nitride layer about 1,500Å thick overlying the silicide layer, and a patterned photoresist layer (not depicted) thereover. The photoresist is patterned to form features each having a width of 1,500Å and a pitch of 3,000Å. The nitride and silicide are both etched using conventional etches. For example, a nitride

etch can comprise the use of 50 sccm CF_4, 50 sccm He, and 35 sccm CH_2F_2 at a pressure of 10 mTorr, an upper power of 700 watts, a lower power of 250 watts for a duration of 60 seconds. The silicide etch can comprise 75 sccm Cl_2 and 25 sccm CF_4 at a pressure of 4 mTorr, an upper power of 250 watts, a lower power of 75 watts for a duration of 50 seconds. Further, as the etch of the test wafers is performed to depict the change in isotropic etching which results from increasing the flow rate of the oxygen-containing gas, the polysilicon is first anisotropically etched to result in a vertical profile. An exemplary polysilicon etch comprises the use of 40 sccm Cl_2, 6 sccm ~~HeO_2~~ $He\text{-}O_2$, and 180 sccm HBr at a pressure of 20 mTorr, an upper power of 160 watts, a lower power of 30 watts, for a duration of 30 seconds.

[0026] FIG. 5 depicts an etch using a flow rate of 6 sccm ~~HeO_2~~ $He\text{-}O_2$, 50 sccm HBr, 100 sccm He, 70 watts lower power, 350 watts upper power, a pressure of 60 mTorr, and a duration of 60 seconds. The resulting etch provides little or no lateral etching or undercutting of the polysilicon 50, the silicide 52, or the nitride 54. This etch would, however, etch polysilicon in a vertical direction and would provide an inventive substitute for the exemplary polysilicon etch described in the previous paragraph. Thus the need for the 30% undercut tolerance described above is reduced or eliminated and a smaller device with increased feature density can be formed.

[0027] FIG. 6 depicts an etch using a flow rate of 9 sccm ~~HeO_2~~ $He\text{-}O_2$, 50 sccm HBr, 100 sccm He, 70 watts lower power, 350 watts upper power, a pressure of 60 mTorr, and a duration of 60 seconds. The resulting etch undercuts the polysilicon 60, especially toward the bottom of the feature. The upper portion of the polysilicon 60 remains substantially vertical. This etch removes the polysilicon at a faster isotropic rate than the etch described with reference to FIG. 5.

[0028] FIG. 7 depicts an etch using a flow rate of 12 sccm ~~HeO_2~~ $He\text{-}O_2$, 50 sccm HBr, 100 sccm He, 70 watts lower power, 350 watts upper power, a pressure of 60 mTorr, and a duration of 60 seconds. The resulting etch removes the polysilicon 60 along the entire height of the feature.

[0029] As is depicted in FIGS. 5-7, increasing the oxygen-containing etchant, for example the ~~HeO_2~~ He-O_2 described, results in an increasingly retrograde etch profile. The etch profiles depicted in FIGS. 5-7 are generally homogeneous across a wafer with stacks at the edge of the wafer having etch rates and profiles similar to those at the center of the wafer or at any other wafer location. Also, the amount of undercut will increase with increased doping of the blanket polysilicon layer.